

almoner of the proprietor of the *New York Herald*. Mr. Stanley's story is known to everyone, and we need not repeat it.

With Stanley, Livingstone explored the north end of Lake Tanganyika, and proved conclusively that the Lusize runs into and not out of it. It will be satisfactory if the discovery of an outlet on the west side, just announced in a despatch from Lieut. Cameron, turns out to be true. In the end of the year the two started eastward for Unyanyembe, where Stanley provided Livingstone with an ample supply of goods. Here Stanley urged his going home, but although he was now inwardly yearning to return, his judgment said, "All your friends will wish you to make a complete work of the exploration of the Nile before you retire." To this purport also was the advice of his daughter Agnes, whom he therefore calls "a chip of the old block." But had his judgment been cool enough, it might have told him that his constitution was so shattered that it was totally unequal to a task of such magnitude. The fountains he was in search of he supposed to be about 400 miles to the west of Lake Bangweolo.

The rest is soon told. Stanley left on March 15, and after Livingstone had wearily waited in Unyanyembe for five months, on August 15 a troop of fifty-seven men and boys arrived, some of the boys being Nassick pupils from Bombay, one of whom was Jacob Wainwright, who afterwards acted so important a part in the home-bringing of his body. Thus attended, then, he started on August 25 for Lake Bangweolo, proceeding along the east side of Tanganyika, over rugged mountains which sorely tried the endurance of himself and his retinue, even though he had two donkeys to ride, a present from Mr. Stanley. His weakness soon found him out; ere he reached the shore of Tanganyika his old enemy dysentery seized upon him, and seems never wholly to have left him, but to have got worse and worse, causing him fearful suffering till the bitter end. In January 1873 the party got among the endless spongy jungle on the shores of Bangweolo, where vexatious delays took place, and where the journey was one constant wade below, and under an almost endless pour of rain from above. The Chambezi was crossed on March 26, and the doctor was getting worse and worse, losing great quantities of blood daily: but he seems never to have dreamed of turning back or of resting. No idea of danger seems to have occurred to him; he had so often before got over difficulties and attacks of all kinds, and he was so full of the object his heart was bent on, that the idea of death does not seem to have entered his head. This, we believe, moreover, is a characteristic of the disease. At last, in the middle of April, he was unwillingly compelled to allow his men to make a *kitanda*, or rude litter, in which he was borne to the end. Still the dreadful illness is spoken of as a mere annoying hindrance. Thus, on the 29th of April, Chitambo's village on the Lulimala, on the south of the lake, was reached. The last entry in the journal, of the last two pages of which a fac-simile is given, is April 27: "Knocked up quite, and remain—recover—sent to buy milk goats. We are on the banks of the Molilamo." On April 30 he was careful to wind his watch, but with the utmost difficulty, and early on the morning of May 1 he was found by the boys kneeling by the side of his bed, dead.

Chitambo behaved generously, and the men, headed by Chuma and Susi, acted with great intelligence, faithfulness, and discretion. Everything was carefully locked up, and the story of the preparation of Livingstone's body for the purpose of carrying it home to his own folk, by "beekin' forenent the sun," is known to all. After a five months' march through many difficulties, the attendants reached Unyanyembe. Here Lieutenants Cameron and Murphy and Dr. Dillon were met, and early this year the body arrived at Zanzibar, and in the end of April was deposited, as was meet, in Westminster Abbey.

A monument with an appropriate inscription has been erected to Livingstone in the Abbey; and doubtless, in time to come, a more suitable memorial will take the place of that rude one placed near the spot where their hero died, by the hands of his loyal and faithful attendants.

Mr. Waller, we think, has on the whole performed his sacred task judiciously, printing the journals, as we have said, exactly as he found them, though many of his parenthetical remarks seem to us unnecessary. The maps are of great assistance to the reader, and will be found of value to the geographer, although in the meantime, so far as Livingstone's last journey is concerned, they must be regarded as to a great extent conjectural. No doubt careful criticism will soon do its work both on journal and maps, and, with the help both of previous and subsequent exploration, test the exact geographical value of the achievements which cost Livingstone his life. The illustrations are interesting and helpful.

BUCHANAN ON THE CIRCULATION OF THE BLOOD

The Forces which carry on the Circulation of the Blood.

By Andrew Buchanan, M.D. Second Edition. (London: J. and A. Churchill, 1874.)

IN the same way that, among *à priori* mechanical philosophers, the possibility of discovering a perpetual motion was a favourite subject of discussion before the development of the theory of energy, so, among physiologists, the relative importance of the different forces which maintain the circulation of the blood was an equally common source of speculation before the introduction of the blood-pressure gauge and the sphygmograph. Within the last twelve or fifteen years, however, the various problems which used to occupy the attention of Magendie, Arnott, and Barry have been completely solved by entirely fresh methods of observation; and these, quite irrespective of their *opinions*, have verified or disproved their theoretical deductions according to whether or not they were based on sound premises.

Dr. Buchanan devotes much of the short work before us to the consideration of one of these bygone points, namely, the pneumatic forces which maintain the circulation of the blood, the importance of which he endeavours to demonstrate by a series of hydraulic experiments, the different elements of which are, we fear, slightly savoured with the bias of preconceived notions, as the result at which he arrives is that "after birth the circulation is mainly carried on by two forces—the propulsive force of the heart and the pressure of the atmosphere, acting nearly in the proportion of three of the former to two of the latter; but that as life advances, and the quantity of

venous blood increases, the latter force becomes relatively more powerful." The most energetic of these auxiliary pneumatic forces is stated to be that of the chest, which is followed in importance by the suction force of the heart and by a "pleuro-cardiac pneumatic force," in which the heart, contracting in a rigid chamber, draws blood into it from the surrounding veins, on account of its decrease in size during the systolic act. The elaborate investigations of MM. Chauveau and Marey,* published a little more than ten years ago, put us in a position to state exactly, in inches of mercury, what are the values of the pneumatic forces which Dr. Buchanan describes; and as these results are evidently not familiar to British physiologists, to those at Glasgow at least, it may be worth while recapitulating them here. First, the sphygmograph trace in health shows that, as Dr. Arnott maintained, normal respiration has scarcely any appreciable effect on the blood-pressure, because the horizontal line joining corresponding points in the different pulse-beats is very nearly, if not quite, straight. These authors also explain how the antagonistic results of Ludwig and Vierordt—in which the one states that the blood-pressure falls during inspiration, and the other during expiration—can be accounted for; they finding that if the air-passages are partially obstructed, as by shutting the mouth and closing one nostril, the one result is produced; whilst if these same passages are freely opened, the opposite effect is observed. The influence of respiration may therefore be dismissed as comparatively insignificant.

That of the heart is much more considerable. By means of a beautifully constructed piece of apparatus M. Marey has been able to demonstrate the existence and amount of the negative or suction forces, as far as they are found to exist in the different cavities of the heart, during the different parts of each cardiac pulsation. His results are recorded by the graphic method;† and their agreement among themselves is evidence of their accuracy. The work referred to contains a full description of the apparatus employed. The following are the results:—In the right ventricle the blood-pressure does not ever go beyond zero, except at its basal portion, where it is *sometimes* found that a minute suction force develops immediately after the closure of the aortic valves, and then only. In the left ventricle an appreciable suction force is observed at the same time as in the right; it is, however, not great. It is impossible, by any means yet devised, to get at the left auricle, but the right auricle is easily arrived at from the jugular vein. In it the blood-pressure is *nearly always* negative or below zero, it being otherwise only during its systole. A study of the auricular cardiograph trace shows that immediately after the auricular systole, which is the same thing as saying at the commencement of the contraction of the ventricles, the pressure in the auricle descends rapidly below zero; that the descent is broken by a small wave, and that the suction force commences to diminish gradually after the closure of the aortic valve, becoming *nil* a very short time before that organ again contracts. The explanation of these changes is not difficult. The rapid fall in the auricular pressure during the ventricular contraction was many years ago fully explained in a peculiarly able

memoir by Mr. Bryan,* and the active dilatation of the ventricles of the heart during diastole, which necessitates a corresponding internal suction force, has been shown by more than one physiologist to depend on the peculiarities of the coronary circulation.

By employing a specially adapted manometer M. Marey was able to measure this suction force in the right auricle of *Equus caballus*, and found that it ranges, on the average, between -7 and -15 millimetres of mercury, the same method giving 120 millimetres as the average pressure in the left ventricle during the systole. From these figures the true relation borne by the contractile force of the heart to its suction power can be readily estimated.

The "pleuro-cardiac pneumatic force" described by Dr. Buchanan is nothing more than that above referred to as described by Mr. Bryan, the latter author having previously demonstrated that on account of the heart—a conical organ—contracting in a conical cavity, it must necessarily advance towards the apex of that cone during systole, and so leave the base to be filled by the absorption of the blood from the distended veins.

These remarks all tend to show that many of Dr. Buchanan's investigations are in the right direction, but that a further acquaintance with the literature of the subject would enable him to employ his considerable ingenuity and enthusiasm in the elucidation of points still remaining unexplained to students of the science of physiology. This want of acquaintance with the works of others is, we think, partly explained by some incidental remarks in the book before us. The author says: "I have always exercised all the branches of my profession. . . . I cannot but regard this custom as much superior to that which our medical corporations are now enforcing, of making every man from the beginning select for himself a single branch of the profession;" to which are added other remarks derogatory to specialisation in study. With these we cannot agree, and still think that "if you wish to find a man of large views of physiological nature," he is more likely to be a special student, with time at his disposal, unoccupied by miscellaneous professional calls, than one who, turning his attention to all things, has no opportunity of concentrating it on any one, to the advancement of our knowledge of its details.

OUR BOOK SHELF

Elements of Animal Physiology. Elementary Science Series. By J. Angell. (W. Collins and Co., 1874.)

THERE is more than one way by which the relative importance of scientific facts may be arrived at. An investigator, whilst prosecuting his independent researches, will not be long in forming a fairly accurate standard, and this he finds it easy to impart to others. Many engaged in educational work find it impossible to afford the time for independent observation or prolonged study, and yet it is their ambition to give their pupils a fairly correct estimate as to those of the innumerable facts surrounding them on which they should lay stress in preparing for a pass examination. The standard with them therefore becomes nothing more nor less than the questions of former years or of other similar examinations; the work which answers the greatest number of these in the most satisfactory manner being looked upon as the most

* Marey, "Circulation du Sang;" Paris, 1863.

† *Loc. cit.* pp. 95, 96.

* *Lancet*, Feb. 8, 1871.